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Hybrid of Smart System Model to Support the Service of Fertility Doctors in Handling In-Vitro Fertilization Patient Complaints

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Abstract

The majority of In-Vitro Fertilization (IVF) patients immediately call a fertility doctor when they experience different symptoms than usual. However, the high workload makes fertility doctors unable to immediately provide recommendations to handle complaints of IVF patients, while the longer wait for recommendations from fertility doctors will increase the anxiety of IVF patients and high levels of anxiety affect the success rate of IVF programs. The Case-Based Reasoning (CBR) model has lower performance than the modified CBR model, and the CBR model adds to the workload of fertility doctors, namely having to handle the revision stage. To overcome these problems, the CBR model was modified by applying the Chris Case-Based Reasoning (CCBR) similarity formula and combining it with the Rule-Based Reasoning model. The results of performance measurements showed that the accuracy score increased to 47% and the precision score remained 100%, so the results of this modification of the CBR model are worthy of being recommended for application to a smart system for handling complaints of IVF patients.

Keywords: *Case-Based Reasoning, CCBR, Hybrid, In-Vitro Fertilization, Rule-Based Reasoning, Smart System, Patient Complaints.*

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1 Introduction

The majority of in-vitro fertilization (IVF) patients have a high level of anxiety [18, 16, 34, 55, 26], so IVF patients immediately call their fertility doctor when they experience different symptoms than usual [18, 20] and ignore the busyness of the fertility doctor [32], IVF patients want the best service [18, 20, 12]. The behavior of IVF patients is caused by: the relatively long time undergoing IVF [35, 23], pressure from the family to have biological children [16], fear that IVF programs will fail [16, 34, 23] and IVF program costs relatively expensive [16, 34]. Several causes of the high workload of fertility doctors [12, 53, 22]: Comparison of the number of fertility doctors with the number of IVF patients is still below the standards set by the World Health Organization (WHO) [31, 38], fertility doctor is sick [18].

The high workload of fertility doctors is the reason fertility doctors cannot immediately provide recommendations on IVF patient complaints. Whereas the condition of IVF patients, the longer they wait for recommendations for handling complaints from fertility doctors, the higher the level of anxiety [18, 20] and the high level of anxiety is one of the factors that influence the success rate of IVF program [18, 55, 26, 17, 27, 8]. It is very important to help fertility doctors who have a high workload through a smart system that is able to provide accurate recommendations for dealing with IVF patients' complaints.

Smart health systems can assist doctors in handling patient complaints [28, 15, 51, 52, 48, 4, 6] by providing accurate recommendations [3, 9, 37, 30, 13, 44]. The Case-Based Reasoning (CBR) model is a model that is widely used in the health sector [21, 46, 40, 36, 14, 50], but has lower performance than the performance of modified CBR models [1, 45]. The CBR model also provides a workload for fertility doctors who are already busy to be responsible for handling the revision stage [12, 53, 22].

This research uses the CBR model that applies the Chris Case-Based Reasoning (CCBR) similarity formula which has been proven to have good performance [19], and combines the CBR model with Rule-Based Reasoning (RBR), because it is also proven to have good performance [49, 54, 10, 43]. This study aims to support fertility doctors to be able to handle complaints of IVF patients by providing accurate recommendations for handling complaints of IVF patients.

2 Research Stages

An overview of the research stages is shown in Figure 1. Research recommendations were obtained from the Ethics Committee of Pekalongan University (letter No.33/B.02.01/KEPK/I/2022) and the Ethics Committee of Duta Wacana Christian University (letter No. 1384/C.l6/FK/2022). The research implementation follows the provisions in "Regulation of the Min-

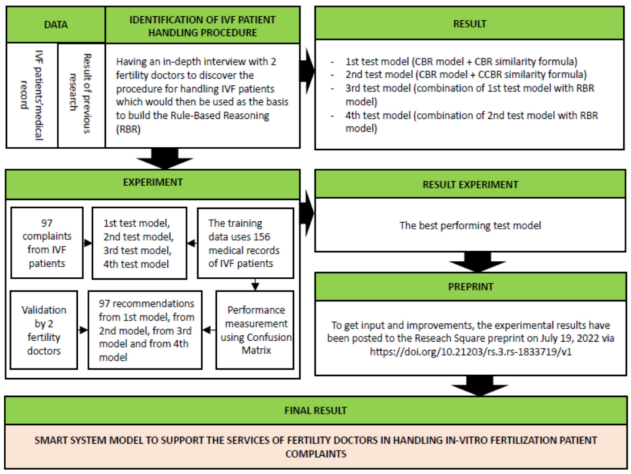

Figure 1: Research Stages.

ister of Health of the Republic of Indonesia No. 30 of 2019" and "Indonesian Medical Council Regulation No. 87 of 2020", which involves fertility doctors who are members of the "Indonesian Doctors Association for In-Vitro Fertilization" as experimental result validators. Research data follows the provisions in "Regulation of the Minister of Health of the Republic of Indonesia No. 269/MENKES/PER/III/2008" namely obtaining IVF patient health records without accompanying the IVF patient's personal identity. The experiment uses a purpose-built application to test the performance of the test model. Measurement of the test model were done using the Confusion Matrix. Experiment results have been posted to Preprint Research Square[1].

3 Results and Discussion

3.1 Results

Based on the agreement of the two fertility doctors, IVF patient complaints consist of 5 types of complaints, each type of complaint has 4 levels and the combination of types of complaints and complaint levels is called a variety of complaints. Each variation of complaint has a different weight and complaint handling and so that the identification of the disease is accurate, for weighting the same complaints but different diseases, different weight values are given[34,44]. The range of weight values used is between 0 and 1 [14, 5, 11, 47]. The details of the two doctors' agreement are listed in Table 2 which is the basis for making the RBR model rules. After having the basic rules for creating the RBR model, the process continues by creating the four test models used in the experiment, as shown in Table 1.

3.2 Discussion

Comparison of the number of recommendations produced between recommendations with a similarity value of $> 80\%$ and recommendations with a similarity

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Table 1: Test Model

Model	Smart System Models	Logical
1st	CBR model	Figure 2
2nd	CBR model with CCBR similarity formula	
3rd	The combination of 1st test model and with RBR model	Figure 3
4th	The combination of 2nd model with the RBR model	

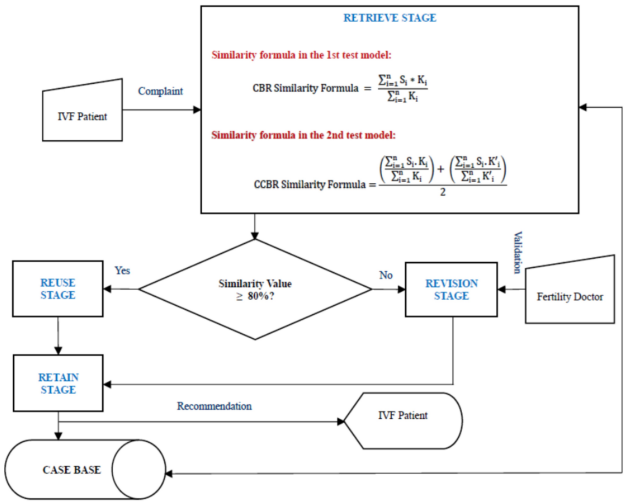

Figure 2: The 1st test model and 2nd test model.

value of $< 80\%$ can be seen in Table 3. The standard similarity value used to express accurate recommendations is $\geq 80\%$, because based on the experimental results, the highest similarity value for inaccurate recommendations is 79.7%. The following is the number of recommendations generated by the 1st test model and 2nd test model which have a similarity value of $\geq 80\%$, and have been validated by two fertility doctors: 1) Of 92% of the recommendations resulting from the 1st test model, only 27% of the recommendations are declared valid by fertility doctors; 2) Of the 42% recommendations resulting from the 2nd test model, 100% were declared valid by fertility doctors. After the validation process from the fertility doctor was completed, performance measurements were carried out in the 1st test model and 2nd test model, the results are shown in Table 3.

Based on the performance measurement results in Table 3, it can be seen that the 2nd test model has better performance than the 1st test model. The 1st test model and 2nd test model use the CBR model, so recommendations with a similarity value of $< 80\%$ must enter the revision stage. However, the heavy workload of fertility doctors [18, 12, 53, 22] makes fertility doctors unable to immediately handle the revision stage of the CBR model. For this reason, the 1st test model was modified into the 3rd test model and the 2nd test model was modified into the 4th test model, modifications were made by combining the CBR model with the RBR model as shown in Figure 3.

Table 2: Complaint, Complaint Handling, and Weight Value.

Complaint Type	Complaint Level	Criteria	Complaint Handling	Weight Value
Bleeding Per Vagina [39, 42, 41, 24]	Normal	Normal	None	0
	A little bit	Blood stains	Patients continue to take medication according to the fertility doctor's recommendations, Patients have sufficient rest time and if complaints are not resolved, Patients immediately plan to take treatment to the Outpatient Unit	0.1
	Medium	The volume of blood that comes out is about one tablespoon	Patients immediately plan to take treatment to the Outpatient Unit	0.5
	High	The volume of blood that comes out like menstruation	Patients immediately go to the Emergency Room for treatment	1
Suprapubic Pain [41, 24, 33]	Normal	Normal	None	0
	Low	Can still do normal activities	Patients continue to take medication according to the fertility doctor's recommendations, Patients drink enough water and if complaints persist, immediately plan treatment in the Outpatient Unit	0.1
	Medium	Complaints disrupt activities	The patient takes paracetamol and plans treatment at the Outpatient Unit	0.5
	High	Unable to do any activity	Patients immediately go to the Emergency Room for treatment	1
Fever [24]	Normal	The patient's body temperature is less than 37.2°C	None	0
	Low	The patient's body temperature is between 37.2°C and 37.5°C	Patients continue to take medication according to the fertility doctor's recommendations, Patients continue to drink enough water and if complaints persist, then immediately plan treatment in the Outpatient Unit	0.1
	Medium	The patient's body temperature is between 37.5°C and 40°C	The patient takes paracetamol and plans treatment in the Outpatient Unit	0.5
	High	The patient's body temperature is more than 40°C	Patients immediately go to the Emergency Room for treatment	1
Nausea and Vomiting [39, 42, 24, 33]	Normal	Normal	None	0
	Low	Capable of doing activities normally	Patients continue to take medication according to the fertility doctor's recommendations, Patients always measure and record their waist circumference, if complaints persist, then immediately plan treatment in the Outpatient Unit	0.11
	Medium	Activities are disrupted	Patients immediately go to the Emergency Room for treatment	0.5
	High	Unable to do any activity	Patients immediately go to the Emergency Room for treatment	1
Sleeping Difficulty [25, 29]	Normal	More than 7 hours	None	0
	Low	Between 6 to 7 hours	Patients continue to take medication according to the fertility doctor's recommendations, Patients continue to eat and drink enough water, Patients continue to carry out normal activities, reduce anxiety, and if complaints persist, immediately plan treatment in the Outpatient Unit	0.25
	Medium	Between 5 to 6 hours	Patients immediately plan treatment in the Outpatient Unit	0.5
	High	Less than 5 hours	Patients immediately go to the Emergency Room for treatment	1

Table 3: Kinerja Test Model.

Test Model	The number of recommendations that have a similarity value of $\geq 80\%$	The number of recommendations that have a similarity value of $< 80\%$	Accuracy Value	Precision Value	Additional information
1st test model	92%	8%	20%	17%	The 1st test model combined with the RBR model becomes the 3rd test model
2nd test model	42%	58%	53%	100%	The 2nd test model combined with the RBR model becomes the 4th test model
3rd test model	-	8% recommendation on the 1st test model, then processed using the RBR model	24%	24%	After the 1st test model is processed with the RBR model, there is an increase in the accuracy value of 4% and the precision value of 7%
4th test model	-	58% recommendation on the 2nd test model, then processed using the RBR model	100%	100%	After the 2nd test model is processed with the RBR model, there is an increase in the accuracy value of 47% and a precision value of 0%

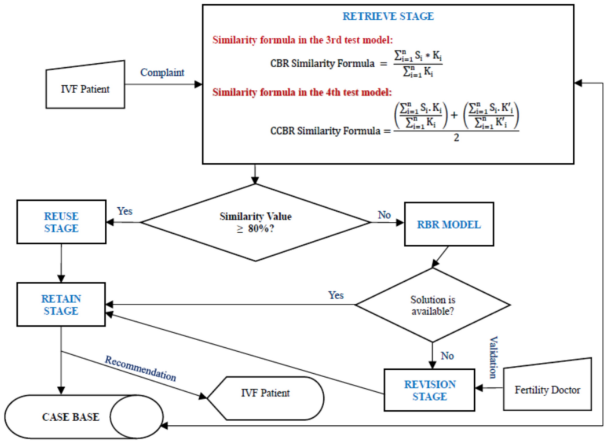

Figure 3: The 3rd test model and 4th test model.

The results of the performance measurement of the test model prove that the 3rd test model and the 4th test model experience an increase in performance compared to the performance in the 1st test model and the 2nd test model. The highest increase in accuracy value was produced by the 4th test model which was 47% with a fixed precision value of 100%, the complete performance measurement results are shown in Table 3.

4 Conclusion

It is recommended to use the 4th test model, a new model from the results of a combination of the CBR model (applying the CCBR similarity formula) with the RBR model, as a model for a smart system for handling patient complaints in IVF programs. This new model is proven to be able to help fertility doctors handle the CBR model revision stage (for recommendations that have a similarity value of $< 80\%$) and is proven to support fertility doctors to continue providing quality health services[55], namely through providing accurate recommendations for handling IVF patient complaints. The limited research scope creates opportunities for further research. The dataset used in the analysis is publicly available[2].

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